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B3A
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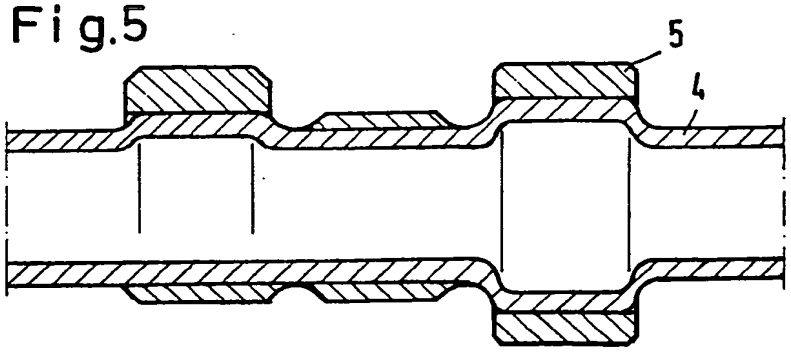
(54) Making camshafts

(57) The invention relates to camshafts. Known camshafts are produced predominantly from solid castings on which selective hardening treatments are applied to produce the desired qualities at the bearing and cam surfaces. As this surface quality must be high, the manufacturing processes are expensive and time consuming. According to the present invention, a camshaft comprises a carrier tube (4) and separate cam-forming elements and/or bearing surfaces in the form of tube portions (5) secured thereto. Securement of the tube portions (5) to the carrier tube (4) may be by soldering or welding; shrink-fitting; mechanical or hydromechanical expansion of the carrier tube (4); or hydromechanical pressing of the tube portions (5) onto the carrier tube. The invention enables the individual parts of the camshaft to be produced separately, and in different materials, reduces the subsequent treatment required to the camshaft; and results in a cost and weight saving.

Fig.5



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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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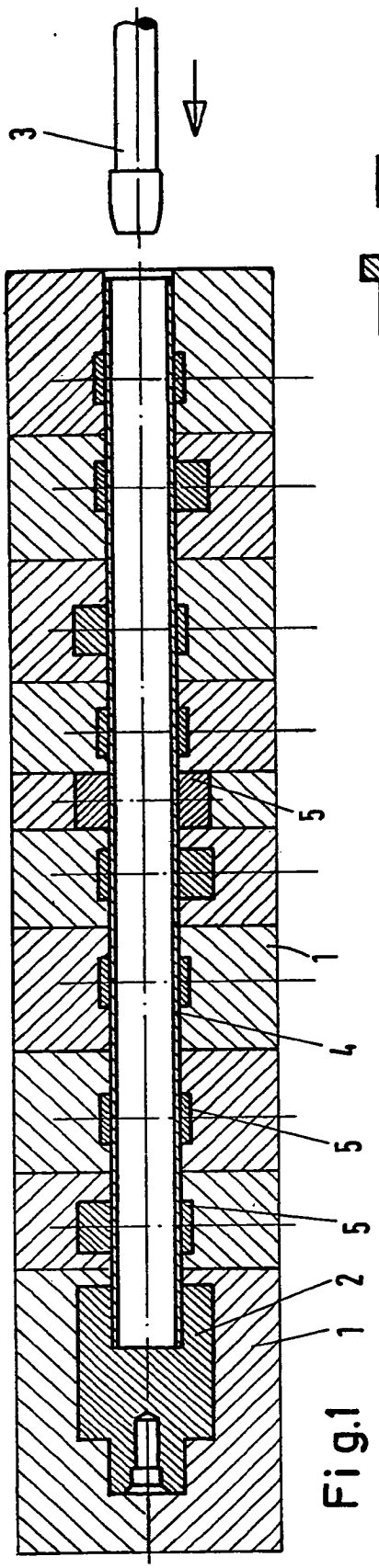

Fig.1

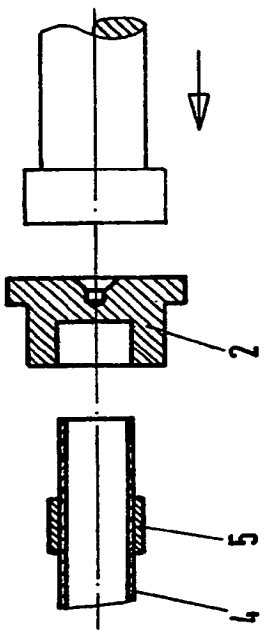

Fig.1a

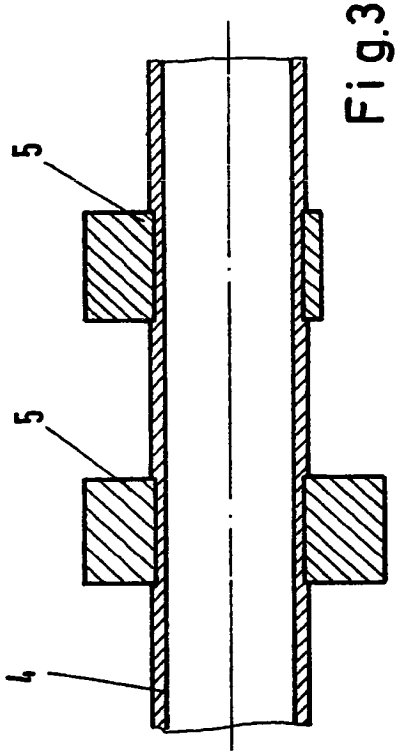

Fig.3

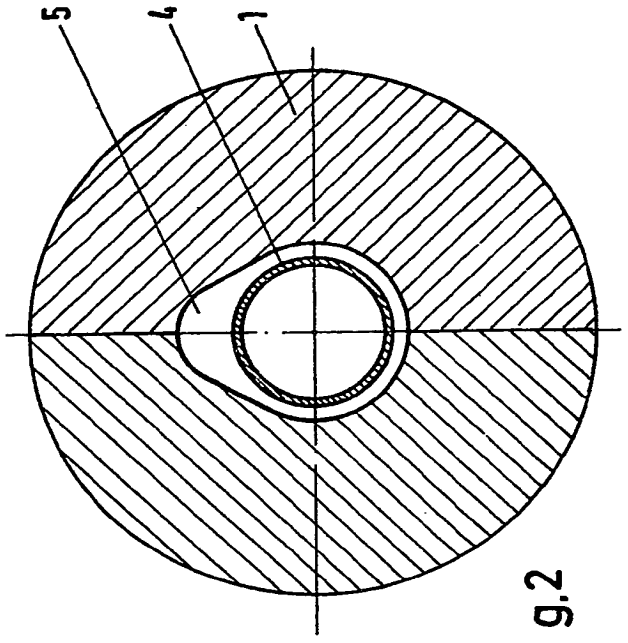

Fig.2

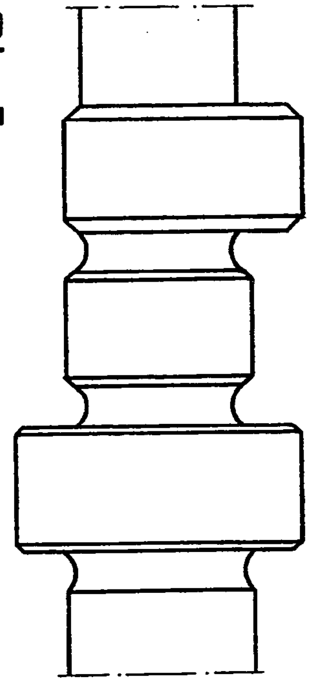

Fig.4

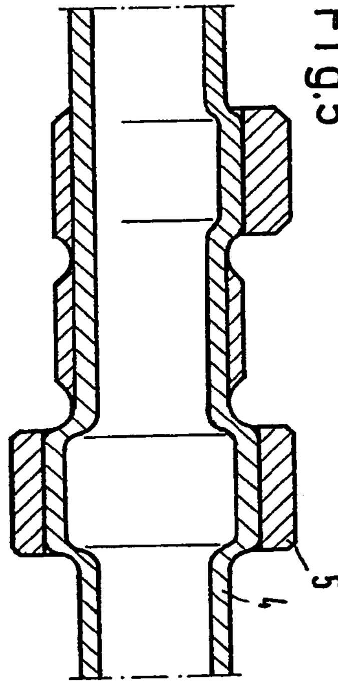

Fig.5

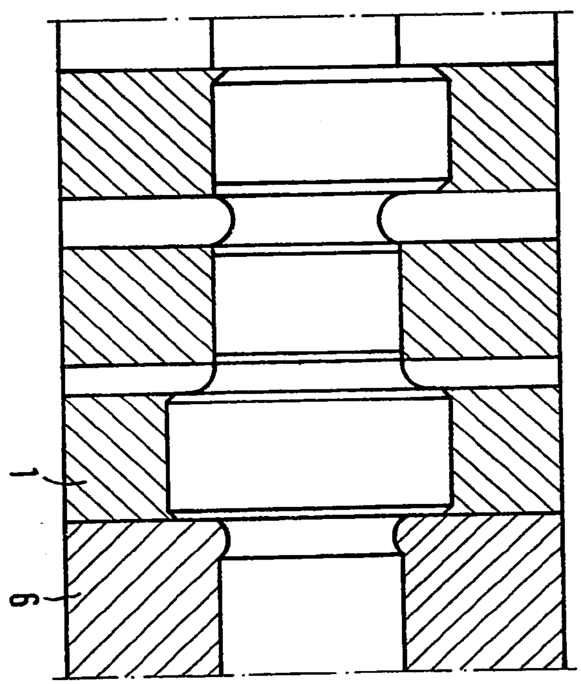

Fig.10

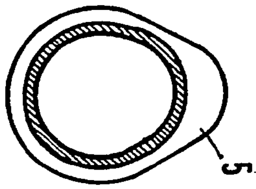

Fig.6

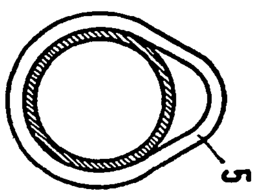

Fig.7

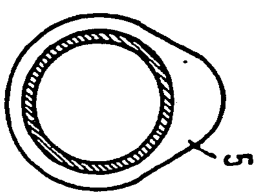

Fig.8

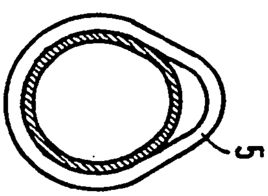

Fig.9

SPECIFICATION

Camshafts

The invention relates to a process for the production of camshafts and an apparatus for performing the process.

Camshafts for the valve control of internal combustion engines are typically produced by drop-forging and, predominantly, by casting. In cast camshafts, the high wear resistance required for the cams can be obtained by inductive surface hardening. For this, the shafts have been made from cast iron containing lamellar graphite and alloyed with chromium and molybdenum, and after hardening the cams have to be ground.

When unalloyed cast iron is used, the required wear resistance of the cams can also be achieved in the cast state without any further treatment by forming the moulding surface for the cams in the die from iron chill, thus causing locally faster hardening of the cast iron in the region of the cams, whilst the carbon in the structure is precipitated as hard iron carbide instead of graphite. The cams thus formed, having adequate surface hardness, are also machined by grinding.

During casting, it is particularly important to ensure that the region in which the moulding surface of the cams hardens more rapidly to give the required formation of the structure is accurately maintained. If the surface area is too small, the wear resistance is reduced. If this special chilling surface is too large, there is a particular danger of cracking and fracture of the cam owing to the brittleness obtained.

To achieve the required fatigue strength and wear resistance, cam shafts may also be salt bath nitrided or tempered.

The production processes mentioned hereinbefore involve high manufacturing costs as the outer layer of the cam surface; i.e., the metallic structure at the surface must be substantially completely free from flaws. In an attempt to reduce these costs without a reduction in the quality of the camshaft produced camshafts according to the invention comprise a carrier tube and separate cam forming elements and/or bearing surfaces in the form of tube portions, secured thereto. Securement may be effected by soldering or welding, shrink-fitting; mechanical or hydromechanical expansion of the carrier tube; or hydromechanical pressing of the tube portions onto the carrier tube.

The invention also provides apparatus for achieving the expansion type securement discussed above, which apparatus comprises a multi-sectional die made up of plates which together define a continuous groove corresponding to the outer diameter of the carrier tube with the bearing points and cams thereon.

Camshafts produced from tubular elements, according to the invention have a number of advantages over those produced by known methods, these advantages being:

(1) the individual parts such as the bearing, cam and carrier tube are easier to produce than in the known processes;

(2) any desired material can be used for all the individual parts, particularly the cams, in order to satisfy to an optimum degree the requirements imposed on the camshaft with regard to fatigue strength and wear resistance;

(3) no subsequent treatment such as salt bath nitriding or tempering is required;

(4) after the individual parts have been joined together to form a camshaft, it is necessary only to straighten the shaft and grind the external diameter of the bearing points;

(5) there is a saving in weight of about 50%;

(6) there is a cost saving.

The invention will now be described by way of example and with reference to the accompanying drawings, wherein:

Figure 1 is a side view of a camshaft consisting of individual components in the die with the tool for joining the individual parts to form a camshaft in the working position;

Figure 1a is a simplified view of the fitting of an end piece;

Figure 2 is a cross-section through the die and through the camshaft in the region of a cam;

Figure 3 is a longitudinal section through part of the camshaft in the region of a cam and an intermediate bearing;

Figure 4 is a side view of a camshaft with cam and bearing point;

Figure 5 is a longitudinal section through Fig. 4;

Figure 6 is a cross-section relating to Fig. 5;

Figure 7 is a cross-section relating to Fig. 5 with the cam soldered on;

Figure 8 is a cross-section relating to Fig. 5 with the cam shrink-fitted;

Figure 9 is a cross-section relating to Fig. 5 with the hydroformed tube and cam with uniform walls; and

Figure 10 is a die in longitudinal section.

The die shown in Fig. 1 is made up of individual sectional plates 1. Incorporated in these plates are the contours for the tube portions which form the bearing points or cams, and also, in this example, the contour for an end piece 2. The tool 3 shown here is used for mechanical expansion of the carrier tube against the bearing and cam forming tube portions. The carrier tube is designated 4 and the individual bearing or cam-forming tube portions are designated 5.

As can be seen from Figs. 4 and 5, the carrier tube 4 is joined to the bearing or cam-forming tube portions 5 in positively locking manner by hydromechanical expansion. It is

also possible to shrink-fit the cam element 5 on to the smooth or expanded tube.

The die used in the production process, which can be inserted in a hydromechanical expanding means, is divided horizontally and vertically and consists of smooth portions 6, and plates 1 for the cam-forming and bearing tube portions.

Figs. 6 and 8 show a cam-forming tube portion 5 consisting of a tube portion with a non-uniform wall thickness and Figs. 7 and 9 show a deformed tube portion with uniform wall thickness.

The carrier tube and the cam-forming tube portions, which may consist of different materials, are placed in the die made up of the plates. In the die, the carrier tube and the cam elements are pressed on to one another by hydromechanical expansion in such a way that a positive joint is obtained. The wall of the carrier tube 1 also presses into the recesses in the plates 6, thus producing bearing surfaces as required.

It is also possible to use cam elements consisting of belt-like strips which are slotted at the carrier tube end and to insert moulded parts between the carrier tubes and the sheet metal strip.

CLAIMS

1. A process for the production of a camshaft wherein at least one of the bearing and cam-forming tube portions are pushed on to a carrier tube and secured thereto.

2. A process according to Claim 1 wherein said securement is by means of soldering.

3. A process according to Claim 1 wherein said securement is by means of shrink-fitting.

4. A process according to Claim 1 wherein said securement is by means of mechanical expansion of the carrier tube.

5. A process according to Claim 1 wherein said securement is by means of hydromechanical expansion of the carrier tube.

6. A process according to Claim 1 wherein said securement is by means of hydromechanically pressing on to the carrier tube.

7. A process according to any preceding Claim wherein the tube portions are portions cut from a pressed tube with an uneven wall thickness.

8. A process according to any of Claims 1 to 6 wherein the tube portions are portions cut from an ovally formed tube.

9. Processes for the production of a camshaft substantially as described herein with reference to and as illustrated by the accompanying drawings.

10. A camshaft produced by a process according to any preceding Claim.

11. Apparatus for performing a process according to Claim 4 or Claim 5 comprising a multi-sectional die made up of plates which together define a continuous groove corresponding to the outer diameter of the carrier tube with the bearing points and cams thereon.

12. Apparatus for the production of a camshaft substantially as described herein with reference to and as illustrated by the accompanying drawings.

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